Case study title:	**National Assessment of Coastal Vulnerability to Sea-Level Rise**

Contact(s):

Name: Erika Hammar-Klose, Geologist
Organization: United States Geological Survey (USGS)
384 Woods Hole Road
Woods Hole, MA 02543
Phone: 508-548-8700
Fax: 508-457-2310
E-mail: ehammark@usgs.gov
URL: http://woodshole.er.usgs.gov/project-pages/cvi

Case study emphasis: Development of a technique that maps the relative vulnerability of a region to sea-level rise, useful for developed and undeveloped coastlines, with examples from the United States.

Summary: A coastal vulnerability index (CVI) was used to map the relative vulnerability of the coastal U.S. to sea-level rise. The CVI ranks the following in terms of their physical contribution to sea-level rise-related coastal change: geomorphology, regional coastal slope, rate of relative sea-level rise, shoreline erosion and accretion rates, mean tidal range and mean wave height. The rankings for each variable were combined and an index value calculated for 3-minute grid cells along the U.S. shoreline. The CVI highlights those regions where the effects of sea-level rise might be the greatest, i.e. where there is the greatest chance that physical changes will occur as sea-level rises. This approach combines the coastal system's susceptibility to change with its natural ability to adapt to changing environmental conditions, yielding a relative and quantitative measure of the system's natural vulnerability to the effects of sea-level rise using objective criteria. Future work will incorporate additional variables such as relative coastal sediment supply, episodic events (hurricane intensity, track, and landfall location, Nor'easter intensity data, and El Nino-related climate data such as short-term sea-level rise) and human influences (e.g., coastal engineering) into the CVI.

Nationally, 30 percent of the U.S. coastline is at very high risk from the effects of rising sea-level. Forty-seven percent of the coast falls into the moderate to high risk range, while twenty-three percent is at low risk. Low-lying barrier islands with a low regional coastal slope characterize those areas of the Atlantic and Gulf of Mexico coasts that are designated as very highly vulnerable. Along the Pacific coast, the most vulnerable locations are pocket beaches lying between rocky headlands, as well as long stretches of low-lying beach. Low risk areas along the U.S. shoreline are typically found in high-relief, rocky coastal settings.

The CVI provides insight into the relative potential of the coastal system to change as sea-level rises in the future. The resultant index data can be viewed in a number of ways: 1) as an example of the potential for using objective criteria to assess coastal vulnerability; 2) as a base for developing a more complete inventory of variables influencing coastal vulnerability; and 3) as a base for developing plans for future investigations related to coastal processes and climate variability.

Date that model application was completed: June, 2001

Case study geographical location: U.S. Atlantic, Pacific, and Gulf of Mexico Coasts

Vulnerability assessment indicators:
We use 6 indicators in calculating the Coastal Vulnerability Index (CVI) – Shoreline Change, Geomorphology, Tide Range, Wave Height, Regional Coastal Slope and Relative Sea-Level Rise.

Methodology data requirements:
The data required for this study are 1) geomorphology, 2) coastal slope (percent), 3) rate of relative sea-level rise (mm/yr), 4) shoreline erosion and accretion rates (m/yr), 5) mean tidal range (m) and 6) mean wave height (m). On the National scale these data were mapped at 3 minute resolution, thus data at this resolution or finer is preferred. Our data sets come from State and Federal agencies, such as NGDC, NOS, the U.S. Army Corps of Engineers, NOAA and the USGS. All of the data assimilation and mapping is done using ESRI products, namely ArcView 3.2. Microsoft Excel is used for the data rankings and the CVI calculation.

Direct participants in the application of the model of the vulnerability assessment:
National Government

Economic and social sector participants directly involved: United States Geological Survey

Methodology objective:
The CVI is intended to be a simple, objective means of evaluation the potential effects of SLR on coastal areas. The CVI ranks the following in terms of their physical contribution to sea-level rise-related coastal change: geomorphology, regional coastal slope, rate of relative sea-level rise, shoreline erosion and accretion rates, mean tidal range and mean wave height. The rankings for each variable were combined and an index value calculated for 3-minute (~3.90 km) grid cells along the U.S. shoreline. The CVI highlights those regions where the effects of sea-level rise might be the greatest, i.e. where there is the greatest chance that physical changes will occur as sea-level rises. This approach combines the coastal system's susceptibility to change with its natural ability to adapt to changing environmental conditions, yielding a relative and quantitative measure of the system's natural vulnerability to the effects of sea-level rise using objective criteria. Future work will incorporate additional variables such as relative coastal sediment supply, episodic events (hurricane intensity, track, and landfall location, Nor'easter intensity data, and El Nino-related climate data such as short-term sea-level rise) and human influences

(e.g., coastal engineering) into the CVI. This method is easily adapted to different data types and resolutions, making it appropriate for use in the Americas.

Methodology output:
This method of assessment results in a table of data, each row of which corresponds to a portion of the U.S. shoreline. The data populating the table are each of the above 6 variables, their rankings and the CVI value. The data area presented as a color coded shoreline that designates each section of the shoreline as low risk, moderate risk, high risk, or very high risk due to the future effects of sea-level rise. The data products include U.S. Geological Survey Open-File reports with maps and interpretations, as well as a U.S. Geological Survey Digital Data Series CD-ROM with all of the data sets for the U.S. Atlantic, Pacific and Gulf of Mexico Coasts.

Results of methodology application at case study site:
Nationally, 30 percent of the U.S. coastline is at very high risk from the effects of rising sea-level. Forty-seven percent of the coast falls into the moderate to high risk range, while twenty-three percent is at low risk. Low-lying barrier islands with a low regional coastal slope characterize those areas of the Atlantic and Gulf of Mexico coasts that are designated as very highly vulnerable. Along the Pacific coast, the most vulnerable locations are pocket beaches lying between rocky headlands, as well as long stretches of low-lying beach. Low risk areas along the U.S. shoreline are typically found in high-relief, rocky coastal settings.

The CVI provides insight into the relative potential of the coastal system to change as sea-level rises in the future. The resultant index data can be viewed in a number of ways: 1) as an example of the potential for using objective criteria to assess coastal vulnerability; 2) as a base for developing a more complete inventory of variables influencing coastal vulnerability; and 3) as a base for developing plans for future investigations related to coastal processes and climate variability.

Lessons learned:
The Coastal Vulnerability Index has been shown to be a simple, yet objective evaluation tool to characterize the risk associated with rising sea-levels. This method is easily adapted to different data types and resolutions, making it appropriate for use in the Americas. Similar hazard mapping for earthquake and volcano risk has been done for the US for a number of years. In an age of rising sea-levels, the CVI has become a necessary and timely tool. Feedback from academic and government scientists has validated the need for the CVI. The National Park Service has requested similar studies in it’s coastal parks and is incorporating the results into their 30-year General Management Plans.